

An Accomp't of three Books,

1. *A Discourse made before the R. Society, concerning the Use of DUPPLICAT PROPORTION in sundry Important Particulars; together with a New Hypothesis of ELASTIQUE or Springy Bodies: By Sir William Petty Knight, &c.*

TH E Author of this Discourse, much addicted to apply Speculations to Use and Practice, hath given in this Exercise of his, *Several Instances, wherein the Consideration of Duplicat and Sub-duplicat Proportion, or the Consideration of Sides and their Squares is of Use in Human affairs.* Those Instances are.

1. In the *Drawing or Driving Powers*, which force Ships or other Bodies through the Water, with reference to the respective *Velocities* caused thereby.

2. In the *Shapes or Sharpness of Bodies*, cutting or dividing the Water, through which they are driven or drawn, and in the different Velocities arising from thence, where the Bodies and Forces are Equal.

3. In the *Strength of Timbers*, or other Homogenous materials applied to Buildings, to Carts, or any other Machinaments intended for Strength: And how by a *Model* to judge the Sufficiency of such Engine as is represented by it.

4. In the *Effect of Oars* upon Equal and Like Vessels, according to their Numbers, Length, Blades and motions *with* or *against* the Stream of smooth or un-even waters.

5. In the Motion or *Travelling of Horses*, on their several Paces, and with different Burthens on them.

6. In the *Strength and Velocity of Mills* and their Wheels.

7. In the effects of *Gunpowder*.

8. In the Distance at which *Sounds* may be heard.

9. In the Distances at which *Odoriferous matters* may be smelt.

10. In the Distance at which the *Objects of Sight* may be seen.

11. In the Time of the Returns made by *Vibrating Penduls*.

12. In the *Lives of Men* and their Duration.

13. In *Musical and Sounding Bodies*, such as Strings and Bells.

14. In the Effects and Motions of *Fire and Burning Spirits*.

15. In the *Rising and Falling of Bodies*, but especially of Water in *Pumps, Over-shot Mills, Leaks in Ships, the Heights of Rivers* at their Head above their fall into the Sea.

16. In *Bellows*.

17. In the *Prices of several Commodities*, as Masts, Diamonds, large Timber, Amber, Load-stones, &c.

18. In *Mill-dams, Sea-banks, and the Bulwarks or Walls of Fortresses.*

19. In the *Compression of Wool* and other *Elastique Bodies*, and of the *Air* within Diving Vessels, as also in the Effects of *Screw-presses* upon several Materials.

Having thus enumerated his several Instances, wherein *Duplicate* and *Sub-duplicate Proportion* is of great importance, he explaines what he understands by every material word he uses in this Discourse, such as *Matter, Body, Figure, Place, Motion, Quantity, Quality, Habit, Time, Proportion, Weight, Swiftnes, Force* and *Elasticity*. This done, he falls to his main busines, which is the Application of the said Proportions to each of the respective Matters lately mention'd. To which he subjoyns an *APPENDIX* touching his new Theory of *Elasticity*, mechanically explicated, to draw forth the Thoughts of other men for Countenance or Correction. This Hypothesis the Author hopes will solve all the Phænomena of *Elasticity*, and not only so, but also those of *Hardness, Fixedness, Tenacity, Fluidity, Heat, Moisture, Fermentation, &c.* Not to prejudice this his Explication by transferring it hither in a Breviat, we shall referr the curious to the Author's own Discourse; wishing, that whatever Effects of *Springing* do occur to the Ingenious Reader, he would please to examine them by the Principles deliver'd by the Author.

These are the particulars, perform'd in this Discourse, which the Author judgeth, may pass for a Sample, *pro tanto*, of what the *Royal Society* is doing. For, the said Discourse consisting of three parts, viz. 1. An Explanation of the Intricate Notions, or *Philosophia prima*, of *Place, Time, Motion, Elasticity, &c*; 2. An excitement of the World to the study of the *Mathematiques*, by shewing the use of *Duplicate Proportions* in some of the most weighty of Human affairs; and 3. A Proposal of considering, without Chymerical Speculations, such points and properties in *Atomes*, as may give an *Intelligible Accompt* of the *Nexures, Mixtures, and Mobilities* of all the parts of the Universe: The Discourse, I say, consisting of these parts, he esteemt, that in like manner 'tis the profession of the said *Society*, to make mysterious things plain; to explode and disuse all insignificant and puzzling words; to improve and apply little small threds of *Mathematiques* to vast Uses; and yet not to neglect the finest Consideration, even of *Atomes*, where the same is necessary.

II. *The second Book of the ART of METTALS*, wherein is taught the Common Way of Refining Silver by Quicksilver, with some New Rules added for the better performance of the same: Written in Spanish by Alonso Barba, and English by the Right Honorable Edward Earl of Sandwich, London, 1674. in 8°.

THE first Book of this subject was discoursed of in the next foregoing Tract. This second consists of 24 Chapters, most of them practical; whereof the two first do instruct the Reader, *with what care and caution a Refiner of Mettals is to be employed*, and *what knowledge such an one is to be furnish't with*, viz. that he is to know the qualities and differences of all sorts of Mettals and Minerals, which of them are most proper for Quicksilver, and which for melting; *item*, the Diseases infecting Mettals, and the way of clearing them; as also the Accidents of Quicksilver, and the way of Refining both in great and little; and above all, the manner how to make the lesser Essay, by the fire, of Ore ground to powder before the Mettal be incorporated together, that so he may certainly know how much Silver (e. g.) is to be gotten out of the Ore of that Mettal: The want of which knowledge and care, *our Author saith*, hath cost the kingdom of Peru abundance of mony, and is still of great prejudice to it; which he proveth by very considerable Experiments, whereby it was made evident, that a vein of Mettal, essayed by the Fire, yielded 900 pieces of Eight the Quintal, which by the ordinary way of Quicksilver yielded but four or five: *item*, that another Mine, which by the common Essay with Mercury appeared to have scarce any Silver at all in it, yet by the other way contained 60 pieces of Eight the Quintal.

The third Chapt. treats of the *knowledge of those above-intimated differences of Mettals*: The fourth teacheth the *way of sorting Ores*, and the proper manner of Refining each of them: Where 'tis made out, that to essay that Mettal by Quicksilver, which requires the fire, is to destroy it; as 'tis to loose the profit, if that Mettal be put in the furnace, which is not to run: And further, though the several Ores be fit for the Quicksilver, and some for Fire, yet even herein they have their differences of being easier or harder to be refined, according as they concur or differ in the remedy that is necessary to be used for that purpose.

The fifth Chapt. informs us, How to know the ill Qualities that infect the Ore, and how to purge them away: Where 'tis noted, that such Ores, as partake of *Copperas*, will not endure Quicksilver, but consume and scatter it; which our Author saith may be easily

tried by mixing a little Quicksilver with well-ground Copperas and Water; whereupon he shall in a trice see all the Quicksilver dissolved and lost, especially putting a little Salt to that composition. How this, and other like inconveniences are found out, and how easily they may be remedied, may be seen in this Chapter at large.

The *sixth, seventh and eighth Chapters*, treat of the *Grinding* and *Burning* of Ore, and the damage that results from this *Burning*. In the busines of *Grinding*, 'tis beneficial to grind the lumps over again, and to grind them very small: to which practise our Author adds another way of preparation, *viz.* by *Boyling*, held by him more proper in all refinings by Quicksilver. As for *Burning*, that is useful, not only, that the Ore may grind the better, but also, that it may be better dispos'd for the Quicksilver to lay hold on, and incorporate itself with the Silver it contains: which burning yet is not to be used in Ores that are mixt with Copperas, the mortal enemy to Quicksilver; the fire not only vanquishing, but on the contrary increasing that substance; of which therefore all Ore, wherewith 'tis mixed, is first to be clear'd by well washing it.

The *ninth* delivers several *Experiments, proving the damages by the Burning of Ore, if they be not known and remedied.* And the *tenth* examines, *Whether the Ore ought to be burnt in the Stome, or in the Meal;* as the *eleventh* assigns the *Materials to be mixed with Ore when 'tis burnt:* Where occasion is taken to represent, that the Diseases of Ore may be known by putting a little of it, ground somewhat gross, upon a red-hot plate of iron, observing well what fume it makes; which if it be white or black, it participates of Bitums of that colour; if yellow, of Orpiment; if red, of Sandaraca; if yellow in the middle and green on the outsides, of Sulphur, &c.

The *twelfth and thirteenth* teach the Refiner what he is to do before he incorporates the \dagger *Caxon* for refining:

\ddagger That is, a Chest full of Ore ground to be refined Where also are set down the Signs, shewing, when the several Ores, diversly mixed and handled accordingly, are discharged either of all their Sulphur and Antimony, or of their Bitum, and the like; as also, when an Ore is well disposed for the Quicksilver, and when not, &c.

The *fourteenth and fifteenth* consider the *nature of Quicksilver, and the Causes and Differences of the Refiners Lis of Quicksilver*, as 'tis call'd, which is Quicksilver divided into very subtle parts, which division is caused by the often passing of it through the Ore although

although it hath no ill quality at all ; but if it hath Copperas in it, it will grind the Quicksilver in great extremity. Now if Quicksilver be without any forain impression upon it, and be dissolv'd into *Lis* which is white, 'tis call'd, as was just now said, *Lis* of Quicksilver ; but *Lis* of other materials is call'd that which is made by Quicksilver of Tin or Lead ; and *Lis* of Silver is the fine and subtle parts of Silver, made by the repassing of the Quicksilver through the Ore, but not as yet joyned and incorporated with it ; which when it is, they call it *Pella*, that is, Ball or Pellet. As to the *Nature* of Quicksilver, 'tis a body of so admirably uniform a substance, and of parts so perfectly united, that even the fire, which seems to be its greatest enemy, is not powerful enough, by dividing, to corrupt or destroy it, as it visibly doth all other metals and bodies, except Gold and Silver.

The sixteentb examsins, *Whether it be fitting, at first to put in all the Quicksilver and other Materials at once, or no?* This Author is for the negative, alledging his reasons for it, and especially Experience, by which, he saith, 'tis found, that the extraordinary cold of much Quicksilver doth accidentally bind up the Ore, and hinder the refining. Which damage, *he saith*, follows also, if men exceed in the quantity of other materials, they put into the Ore that needs it, because it so dulls the Quicksilver, that it will lay hold on no Silver at all ; which therefore will very hardly ever be reduced into that condition it ought to be. Yet he advertises withal, that if it be needful to refine with *Lime*, his rule will not serve in that case, but the Lime must be put-in all at once, taking especial care, that you do not put in too much of it, because that that greatly hinders the Quicksilver from laying hold of the greater plate.

The seventeenth, discourses of the *Often repassing the Quicksilver through the Ore, and the Effects thereof*: And the eighteenth and nineteenth, enumerate divers *Accidents, which happen in the way of Refining by Quicksilver, and their Remedies*: Where he observes, that if the Quicksilver be very much charged, above what it ought, with materials, such as Lead, Tin, Iron, Lime, it will not appear orbicular, but prolonged like little worms, and if it be stirr'd about the Tray without water, it will make drops with little tails, and stick to the fides of the Tray : And when it is of this condition, 'tis a sign, *saith he*, that 'tis killed or its virtue obtunded from laying hold on the Silver. Which evil how 'tis to be remedied, is at large declared in the same Chapters.

The twentieth and one and twentietb, instruct us, *How to know, whether*

whether or no the Caxon be ready for washing: And, that the washing of the Caxons causeth the loss and waste of Quicksilver. As to the former, he shews, that no small experience is necessary to know that particular; since, if the Caxon be not ripe for washing, that plate which the Quicksilver hath not laid hold on, is likely to be utterly lost; or, if it be not, it must be ground over again. And here he sets down a sure and infallible rule, as he accounts it, for the discovery of the disposition of the *Caxon*; reflecting on the rules hitherto deliver'd for that purpose. As to the latter, he asserts, that the immediate cause of that mischief of the Quicksilvers imperceptible getting out of the *Caxon* with the water or the *Lamas*, is, when the Quicksilver is made over-thin without body or weight, as 'twere, so that it hath nothing to sink it to the bottom of the Caldron, and with stirring the *Caxon* when they wash it, it mixes itself with the dregs and dirt, and goes along with them.

The two and twentieth sets down the *True causes of the loss of Quicksilver, and their Remedies.* Where the Author makes the repassings to be the remote cause of wasting the Quicksilver, and Copperas to be of its own nature, as hath been already noted, a violent cause of extenuating the Quicksilver, and of destroying the greatest part that hath been wasted of the same. In the working of which ill effect, the Salt, used in Refining, and in washing the *Caxons*, contributes not a little; as the *Lamas*, mingled with the water, thickens it, and resists the sinking of the Quicksilver, which stays and is thrown away together with it. See the Remedies in the Author himself.

The three and twentieth and four and twentieth, do explain the *way to make the Pine-Apples, and to clear them of the Quicksilver.* When Refiners have taken the Plate and Mercury together out of the Caldron, straining it, to make them the thicker through two course cloaths wetted, and when they have also beaten it with a Battledoore to squeeze as much Quicksilver through the cloaths as is possible, they make *Pine-apples* of the dry Pellets in moulds fitted for that purpose, socalld from their similitude to that fruit, by reason of their pyramidal figure: Of which Pines those that have been reasonably well strained, $\frac{1}{2}$ will be Silver; so that 100 pounds of Pellets will produce 20 pounds weight of Silver. Here the Author takes occasion to relate the vastness of the loss in clearing the Ore again from the Quicksilver, which he proves from Experience, whereby it appear'd, *he saith*, in the City of *Potosi* alone, at the time of his writing, when the Trading in Mettals ran but low, that yet

communibus annis above thirty thousand pieces of Eight were wasted by the expence of Quicksilver: Which inconvenience hath proceeded, in his opinion, from want of care in seeing the Vessels, used in the recovering of Quicksilver, made of good stuff, and shut very close. Where he takes notice, that at *Oruro*, famous for Gold and Silver-mines, on the top of a hill there is a little vein of white Earth, whereof they make Vessels for use, which when baked become so close and firm that they are not inferior to the best *China*, and are very useful for the making of Crucibles. But where such Earth is wanting, he directs, that that Clay, which is ordinarily used in making the vessels for recovering the Mercury, be the better mingled with the scum or dross of Iron ground very fine, and so made up and baked very well; and that then there shall not be so much Quicksilver lost in the use of them, as is by those now in common use, &c.

III. *Animadversions on the First part of the MACHINA CÆLESTIS of the deservedly famous Astronomer Johannes Hevelius, &c. together with an Explication of some INSTRUMENTS, made by Robert Hook P. of Geom. in Gresh. Coll. and Fellow of the Royal Society. London, for John Martyn Printer to the R. Society, at the Bell in St. Paul's Church-yard, 1674.*

THIS Piece consists, as the Title intimates, of two main parts. The One represents the Authors thoughts of the *Astronomical Organography* of the Excellent *Hevelius*, both examining his, and *Ticho Brabe's* Instruments, and undertaking to evince, that if they had made use of *Telescopical Sights*, their Observations might have been much more exact than they are; forasmuch as, in the Author's opinion, an Instrument of *three foot radius* with Telescopes, will do more, than one of *sixty foot radius* with Common Sights. The other describes an Instrument for taking all sorts of Angles and Distances in the Heavens, which, if increas'd in bulk, is capable, saith Mr. *Hook*, of as great accurateness, as the Atmosphere will ever permit Cœlestial Observations to be made. Its perfection he places in these *seven* particulars: 1. In the *Sights*, which are such, saith he, as may be made to discover the minutest part discoverable in an Object, not at all straining the eye, and fit for alleyes. 2. In the *Divisions*, which are such, as will distinguish the Angle as minutely as the Sight will distinguish the parts or objects, and that even to *Seconds*. 3. In such a contrivance of the Sights, that with one glance of the eye, both the Objects, though a *Semi-circle* distant; are *at once* distinguish't and seen.

seen together. 4. In the Method of setting it exactly perpendicular to a *Second*, if need be. 5. In its *Fixation* and *Motion*, it being so fixed and moved, that, if once set to the Objects, it continues to move along with them, as long as 'tis necessary to continue, or be very certain of, any Observation. 6. In its being to be made and adjusted without difficulty, and not to be put out of order without design; as also in its great easiness of being rectified and again adjusted. 7. In its being not very chargeable.

All these perfections the *Author* explains, and endeavours to make good, by describing and delineating this Instrument and all the parts thereof, and endeavouring to obviate such exceptions, as he fore-saw might be made against it. To all which he annexes occasionally something that relates to the priority of the Invention of the *Circular pendulum*; and likewise a Description of a Wheel-work, which, *he saith*, may be called the perfection of such work, having the perfectest Idea, he thinks, that toothed Wheel-work is capable of, performing the same effect, as if the Wheel and Pinion had an indefinite number of Teeth. Which done, he describes the Frame for keeping the Instrument, which is the main Argument of this Book, in its Perpendicularity, and yet always in the *Azimuth* of the Cælestial object; with a Digression of the great Use of this Principle in Dialling, Equalling Time, Clock-work, &c.

He mentions also a Mechanical way, he hath, of calculating and performing *Arithmetical* operations, much quicker and more certainly, than can be done by the help of *Logarithmes*.

He concludes the whole by shewing divers of the particular Uses of this New Quadrant, as 1. For measuring the Refraction of the Air. 2. For regulating the Places of the Fixt Stars and of the Planets. 3. For stating the Latitude of Places. 4. For examining the Influences of the Planets on the Earth. 5. For measuring the quantity of a Degree upon the Earth, 6. For measuring seen Distances. 7. For Levelling. 8. For taking the Diameters of the Sun, Moon, and other Planets. Where, by the by, are mention'd two other Instruments, one for taking Diameters to *Seconds*; the other, for looking on the body of the Sun without harming the eyes.

Errata left uncorrected in Numb. 108.

Pag. 170. l. 2c. r. *Stores of Salt.* p. 185. l. penult. r. sometimes to the thickness of a flem.
p. 187. l. 15. r. *brought.* ibid. l. 30. r. *did coagulate.*

L O N D O N,

Printed for *John Martyn*, Printer to the Royal Society, 1674.